

SYSTEMATIC MAP

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What do we know about the impacts of the Marine Stewardship Council seafood ecolabelling program? A systematic map

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Abstract

Background: Voluntary Sustainability Standards and ecolabels are market-based mechanisms used to encourage producers and consumers toward environmental sustainability. The Marine Stewardship Council (MSC) aims to improve ocean health and promote a sustainable seafood market. There is growing interest in the program's impacts (direct and indirect) from changes to fisheries management and consumer awareness to market access and the reputation of fisheries. To better understand what is known about the program's impacts and the quality of evidence available, this map collates and describes articles on the environmental, social, institutional and economic effects of the MSC, identifying the methods used to determine impacts, and highlighting knowledge gaps and clusters.

Methods: Following an a priori protocol, systematic searches of peer-reviewed literature were conducted in Web of Science, SCOPUS and AGRIS. Grey literature was gathered from Google Scholar, Microsoft Academic, and three subject-specific websites. A total of 771 articles were retrieved, 271 of which were screened at full-text. 28 articles met all inclusion criteria and a further 37 met all the criteria but did not have a comparator. Additionally, 108 articles that describe the MSC but do not investigate its impacts (thus failing on 'comparator' and 'outcome' inclusion criteria) were included in the narrative report. This provides an overview of MSC topics that are of general interest to researchers in comparison to articles that investigate MSC's impact.

Results: Evidence of the impact of MSC certification fall in the following topic categories: economic (38%), environmental (25%), governance (29%) and social (8%). These articles documented diverse outcomes related to MSC certification. The most common are price premiums, market access, changes in stock health, ecosystem impacts and fisheries management changes. A key knowledge gap are articles on the effects of the MSC's Chain of Custody Standard and its effects on the supply chain. Generally, literature focused on European and North American fisheries with little focus on fisheries situated in lower-income countries.

Conclusions: Research interest in the MSC has grown over the last two decades, however, little research uses study designs and evidence that can robustly detect or attribute change to the MSC. Greater focus on conducting robust quasi-experimental designs would help to better understand the program effects. Comparing areas of interest in the general literature (which, for example, shows greater focus on the governance aspects of the programme than found in literature using comparators) suggests that this is partly due to lack of resources, data access and the challenge of obtaining counterfactuals. Nevertheless, some topics were absent in all areas, such as the social and economic dynamics that link harvesters and supply chain actors. It is important to fill the identified knowledge gaps as the

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behaviours of certified harvesters, supply chain actors and other stakeholders are the key through which the public influence sustainability, market inclusion/exclusion operates, and inequality is generated. Understanding these processes can have wider relevance in the field, informing the design of other sustainability interventions.

Keywords: Voluntary sustainability standard, Sustainable fisheries, Market-based incentives, Impact evaluation, MSC

Background

As the need for sustainable use and consumption of natural resources has become more pressing [23], Voluntary Sustainability Standards (VSS) and ecolabelling programs have gained traction as pragmatic drivers of positive change [25, 47]. By setting social and environmental standards for transnational production as well as certification programs to verify compliance, VSS offer a new regulatory form at the “intersection of market-based instruments, regulation by information, and voluntary private governance” [44]. Today there are many VSS organisations such as Fairtrade International, Rainforest Alliance and the Forestry Sustainability Council. Although they focus on different commodities, they share a similar strategy or ‘Theory of Change’. The Theory of Change describes the assumed causal chain of events that links the VSS intervention with the desired outcome.

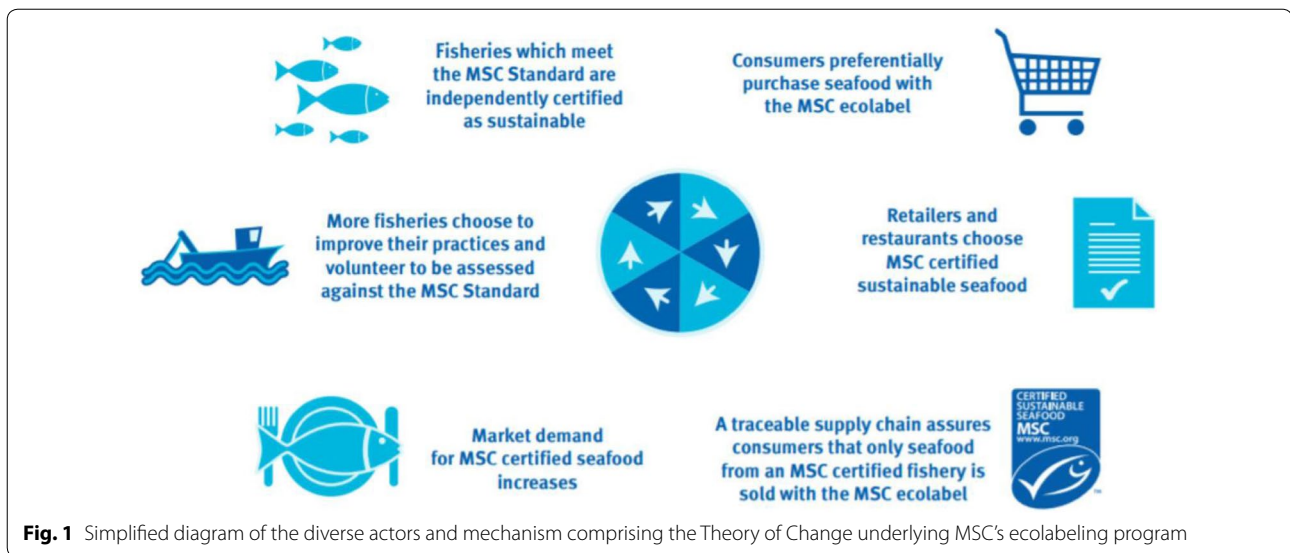
The Marine Stewardship Council (MSC) is one such program, founded in 1997 from a partnership between WWF (an environmental NGO) and Unilever (a global seafood retailer) [21]. The MSC’s stated mission is to use its “ecolabel and fishery certification program to contribute to the health of the world’s oceans by recognising and rewarding sustainable fishing practices” [32]. The organisation is intended to provide a market-based incentive for all fisheries to voluntarily improve their harvesting practices and meet benchmarks laid out in the MSC’s Fisheries Standard, as well as a means of verifying traceability through the MSC Chain of Custody (CoC) Standard.

The Fisheries Standard articulates several sustainability requirements under three environmental sustainability principles: Principle 1 addresses the health of the harvested population; Principle 2 the mitigation of the environmental impacts of fishing on other species, habitats and ecosystems, and Principle 3 addresses effective management and governance systems. The Standard is explicitly focused on environmental sustainability and only includes social dimensions of sustainability in its Third Principle. The MSC’s Theory of Change posits that fisheries will adopt more environmentally sustainable practices and/or initiatives in order to be found to meet these requirements. For example, a fishery might start casting fishing lines at night to avoid accidental bird entanglements or mapping the seabed to identify and avoid any vulnerable habitats, to pass a certification audit. Fisheries are not certified by the MSC, but rather assessed by

independent third-party certificate accreditation bodies [29]. For a product to exhibit the ecolabel, all companies in the supply chain that have handled that product (including buyers, processors, traders, and retailers) must be certified against the CoC Standard. This guarantees full traceability “from ocean to plate”, ensuring credibility of the claim associated with the ecolabel that the product was sourced from MSC certified fisheries.

The MSC Theory of Change assumes that if products with the ecolabel obtain market advantages over non-certified products (e.g., price premiums, or access to new markets), this in turn incentivises more producers to improve and thereby meet the requirements for use of the ecolabel. More ecolabelled products visible on the market can, in turn, generate more consumer awareness, retail demand and interest in certification; a virtuous cycle that drives program growth. As more fisheries strive to align their practices with the MSC’s Standards, improved practices should drive positive environmental impacts. This cycle is illustrated in a simplified graphic representation of the MSC’s Theory of Change in Fig. 1 [30].

The MSC Theory of Change therefore describes the key actors involved and the assumptions around their responses to certification and ecolabelling. However, the organisation’s activities and effects go beyond this simple typology. For example, the MSC runs a capacity building program and provides tools (such as operational guidance and a register of technical experts) to help fisheries on their pathway to sustainability which can improve access to sustainable fishing practices and MSC certification. These additional activities and causal pathways are shown in Additional file 1. Furthermore, there are more potential pathways and indirect or emerging effects beyond those simplistically described in these diagrams visualised for communication purposes on the MSC website [30]. These emerging effects are embedded in the wider socio-ecological system in which the MSC program operates. For example, as an indirect effect of becoming certified, fisheries might improve their reputation and thus their social license to operate, which in turn may have economic or social benefits [10]. Certification may also facilitate improved cooperation between managers and producer organizations, empowering fishers to have a stronger voice [35]. CoC certification may influence product longevity and lower the risk of ecolabelled



products being withdrawn from shelves in grocery retailers [41].

Given the potentially wide-reaching expected and unexpected effects, it is important to understand whether impacts of VSS such as the MSC are occurring as intended. In 2012, a team of researchers tried to address this question; reviewing a range of VSS and evaluating their claims of environmental impacts [42]. However, their study found that qualitative snapshot studies (i.e. non-longitudinal case studies) predominated, with a low number of articles involving counterfactuals and quasi-experimental techniques. Altogether, only 3 articles on the MSC passed their inclusion criteria. A recent review aimed at updating the 2012 study and following a similar protocol [25] found only 5 new articles, on the MSC. Not only did [25] find few articles on ecolabelling programs, but noted that, amongst these studies, seafood ecolabels (including the MSC and the Aquaculture Stewardship Council (ASC)) had the fewest rigorous impact evaluations, i.e., those based on using comparators to establish whether a change occurred and whether attribution to the certification program could be established. Although this may be understandable in the case of the ASC, as the program is relatively recent (founded in 2010), it is cause for concern for the MSC that is over two decades old.

To better understand the state of evidence of the impacts of the MSC, a systematic map protocol [2] was developed to explore all reported types of effects (environmental, social, governance and economic). The protocol aims to identify the most frequent topics of interest in the literature on MSC, and the methodologies and evidence base used. In addition, the protocol aims to establish to what degree research questions are aligned

with the impacts expected based on MSC's own Theory of Change.

In particular, the map has collected articles that have attempted the detection and attribution of change. Here, the terms 'detection' and 'attribution' are used in a broad sense, without implying statistical significance. 'Detection' refers to the process of observing and identifying a specific change, while 'attribution' refers to the identification of its cause. Thus, quasi-experimental studies that use either before-after (BA) or control-intervention (CI) comparators, can be considered attempts at detection, while those that use both before-after and control-intervention comparators (BACI) are more likely to be attributive. However, different types of knowledge arise from disciplines that are underpinned by different philosophical and methodological assumptions and are useful in their own contexts, despite falling outside of the epistemological frameworks commonly used to assess evidence [13]. It is recognised that quasi-experimental study designs are not feasible (or desirable) in all contexts and the concept of a hierarchy of evidence can be contentious when used outside of the medical sciences (where it was first developed) with debates regarding the relative merits of observational and experimental studies being longstanding [13, 37]. In fact, assessing evidence on environmental outcomes according to medical standards could mean excluding much of the available evidence [14]. Therefore, articles that pass the inclusion criteria of this map, but lack comparators, have also been included (though noted separately) to acknowledge the barriers facing quasi-experimental studies.

This report will generate awareness of the existing published material on the MSC program. This includes the

MSC's environmental, social, governance and economic effects, as well as broader lessons learned about market-based approaches to tackling sustainability, and the evidence they draw on. It also identifies the topics that have most drawn the attention of researchers, highlighting not only knowledge clusters, but also knowledge gaps that may help inform future research efforts.

We expect this information to be utilised by multiple end-users involved in studying or implementing sustainability interventions, especially if applied to fisheries and the marine environment, such as marine-focused NGOs, the MSC and other ratings and certification schemes, scientific management advisors and academic researchers.

Stakeholder engagement

The questions asked, and methodology employed in this systematic map were formulated and developed with input from an advisory group comprising external researchers and MSC staff. Researchers provided expertise in the social sciences and economics, and experience in systematic mapping. MSC staff provided practitioner experience in development and application of the MSC certification Standards and processes, and expertise in fisheries biological sciences, marine ecology and seafood traceability.

Stakeholders sat on the advisory group and provided input through the review process including the coding, analysis and write-up stages. The intention was to capture all aspects and perspectives of the programme in the mapping process, addressing stakeholders' concerns and ensuring balance between the perceptions of external researchers and internal staff.

Following the acceptance of the protocol [2] for publication, meetings were held at the MSC headquarters in London on 17 January 2019 and again on 20 May 2019 and remotely on 28 May 2019. These meetings were held to discuss the coding and data extraction procedures and, once the results had been finalised, to identify knowledge gaps and clusters. In addition, discussions on results occurred via email and the advisory group provided feedback and input contributions on the draft manuscripts and final report.

Objective of the review

The primary aim of this systematic map is to describe the documented impacts of the MSC program in published English language literature, including environmental, social, governance and economic effects.

The secondary aims are to document the type of study design and evidence that research on the impacts of the MSC draws upon as well as describe, more broadly, the topics of interest across all literature focusing on the MSC program. This includes literature that focused on

the MSC but didn't explore impacts and thus wasn't analysed as part of the primary aim. This will help identify areas most commonly researched, and knowledge and evidence gaps, informing potential future research priorities of interest both to the research community as well as MSC's Monitoring and Evaluation work.

Primary question

What is the evidence for impacts of the MSC program?

This question has the following components:

- Population: Any harvester groups or chain of custody companies, governments, communities, biological populations and ecosystems affected by MSC certification or have the potential to become MSC certified and affected by such certification.
- Intervention: MSC certification (according to the MSC Fisheries or Chain of Custody Standards)
- Comparator: Absence or presence of intervention either between fisheries, countries, sites or groups, and/or over time.
- Outcome: Positive, negative, neutral or ambivalent impacts on ecosystems, trade, socio-economic outcomes, governance, management or policy.

Secondary questions

- What are the characteristics of the MSC certified fisheries that are most reported in the literature?
- What are the primary topics of the literature that focuses on the MSC and its effects?
- What study designs are used in research regarding the MSC programme and its effects?
- What are the types of outcomes for which evidence is documented?
- What is the frequency of these documented outcomes?
- What are the current knowledge clusters?
- Where do gaps exist in the evidence base that may be prioritised for future research?

Methods

The methods are those published in the a priori protocol [2] and conform to ROSES reporting standards (see Additional file 2). The protocol was developed with inputs from the advisory group. This process was intended to minimize subject bias and ensure a representative systematic map that would answer the stated questions. Additional data on the percentage of fisheries

(by region, country, species and gear) in the certification scheme was sourced from MSC's internal databases [28].

Deviations from protocol

Here we describe all deviations from the protocol [2]. These surround changes to the secondary questions as well as adjustments to the screening and data coding strategy and a clarification of the inclusion criteria.

One of the secondary questions presented in the published protocol, 'What are the primary disciplines that focus on the MSC program and its effects?', was modified to 'What are the primary topics that focus on the MSC and its effects?'. This was done because during the data coding and extraction process the interdisciplinary nature of the subject matter meant that it wasn't possible to easily assign articles to one discipline. Moreover, such categorisations appeared subjective, providing little additional insight into research approaches as well as less direct indication of areas of interest than what could be achieved by simply describing the research topic, and capturing if it was case-study specific or applied across geographic regions, and based on theoretical or empirical observations.

It was also found that answers to the secondary question, 'What are the characteristics of documented evidence in terms of focus of the study (e.g., consumer willingness to pay, program legitimacy and credibility, fisheries bycatch etc.)' were the same as those to the secondary question, 'What are the types of outcomes for which evidence is documented?'. An article focusing on consumer willingness to pay or fisheries bycatch usually reported these as outcomes of MSC certification. Determining article outcomes required less subjective judgement than categorisations of study focus, thus the former question was removed, and the latter retained. Outcomes as they were reported in each article were captured as free text and are shown in Additional file 3. Results of the number of articles categorised by discipline and study foci are captured in Additional file 4.

Additionally, changes to the screening and data coding strategy as described in the protocol were made. Firstly, instead of the performance of consistency checks using kappa tests, followed by individual screening as described in the protocol, double screening and double coding of all articles was done. This change occurred to ensure greater consistency of screening and coding, especially when handling more qualitative articles. Secondly, changes to the data extraction form categories and labels were made. The coordinates and 'FAO major fishing areas' (i.e., internationally recognised spatial divisions of the world oceans, created by the UN World Food and Agriculture Organisation) of where fisheries operate were not captured due to a lack of consistent accurate geographic

information supplied in articles. Furthermore, the following labels were captured in the data extraction process but not described in the narrative synthesis of the map: 'Intervention type', 'MSC impact' and 'MSC impact tested against the MSC's intent'. 'Intervention type' was found to be uninformative in better understanding the impacts of the MSC program. 'MSC impact' was duplicative as 'presence of MSC impact' is inherent in the inclusion criteria and 'description of specific MSC impact' is already captured under 'Outcome'. Furthermore, information on 'whether the evidence for the impact is direct or indirect' is implicitly captured under 'Data source'. Finally, the label 'MSC impact tested against MSC intent' was not completed. This is because it was difficult to consistently and objectively determine 'whether an article examines MSC's impact against MSC's own Theory of Change and/or vision and mission, and/or standards'. The difficulty lies both in the level of nuanced understanding of the MSC Theory of Change and Program documents required to make such a determination, and in the inherent subjectivity of establishing this, at least without generating a very clear protocol to guide the coders (an effort that would've been out of scope). Thus, for the sake of the reproducibility of this report as well as to reduce potential inconsistencies and/or bias, it was not included.

Finally, for the purpose of clarity, 'relevant types of study design' under 'Inclusion and exclusion criteria' was modified to state that syntheses (e.g. systematic maps, systematic reviews, meta-analyses or meta-syntheses) are not included in this map but noted separately. This is because secondary articles are not usually included in systematic maps to avoid double-counting. Syntheses are instead used as a potential source of additional, eligible articles.

Search for articles

Search strategy

The following Boolean string was used to search articles in the databases:

"Marine Stewardship Council" OR "fisheries certif*" OR "certif* fisheries" OR "seafood eco-label" OR "seafood ecolabel" OR "seafood eco label".

Only English terms and literature were included due to language constraints for the advisory group and the coders. No restrictions on document type were applied, however only literature published between 1997 and January 2019 were included. 1997 is the year of MSC's founding, with the first fishery certified in 2000.

This Boolean string was chosen following a scoping exercise, described in the protocol [2], using a test list of ten articles that the advisory group had identified as examples of articles that are relevant to the primary and secondary questions. The list included a range of authors,

topics, study designs and publication years thought to be representative of the literature and likely to answer the primary question. The articles were successfully found using the search string, thus confirming that the search string was appropriate.

Publication databases

The following online databases were searched between 10 and 17 January 2019:

1. Clarivate Analytics Web of Science™ Core Collection <http://apps.webofknowledge.com/>.
2. Elseviers' SCOPUS <https://www.elsevier.com/solutions/scopus>.
3. AGRIS database <http://agris.fao.org/agris-search/index.do>.

Search engines

The same search terms were applied in Microsoft Academic (<http://academic.research.microsoft.com>) and Google Scholar (<https://scholar.google.co.uk>). For the Google Scholar search, 'Harzings publish or perish' plugin (<https://harzing.com/resources/publish-or-perish>) was used to extract the first 250 entries (chosen as the cut-off point as it was considered likely to capture the most relevant articles).

The articles found by the search engines were screened with the same method as those found in the databases.

Supplementary searches

In addition to searches in databases, we performed direct searches in the grey literature published in organisational websites [including WWF, FAO and ISEAL Alliance (<https://www.isealalliance.org/>)]. Literature was also provided directly by members of the advisory group who also called for extra literature through their own contacts. The references from other relevant reviews (e.g. [10, 25, 36]) were included if they had not been found through the initial searches.

Estimating the comprehensiveness of the search

The comprehensiveness of the search strategy was assessed by comparing results to a list of benchmark articles. This list was the same used for the scoping exercise [2]. The list covers a range of authors and topics including articles on environmental management, consumer awareness, developing world presence, including quantitative analyses of fish population health assessments as well as qualitative evaluations of stakeholder perceptions of the program.

Article screening and study eligibility criteria

Eligibility criteria

Relevant subjects All fisheries, countries, communities and biological populations or ecosystems that have been or are potentially being certified. Additionally, any fisheries, companies, communities, biological populations or ecosystems that have been affected by MSC certification (clearly stated in the literature). Official documentation related to the certification process (e.g. Public Certification Reports or formal objections) were not included as they do not examine the impacts of the MSC programme but rather are an integral part of the programme itself.

Interventions Any MSC certification. Additionally, impacts of MSC certification on fisheries, countries, communities and biological populations that have yet to be certified were included but noted separately.

Relevant comparators The absence or presence of interventions either between fisheries, countries, sites or groups (Control-Intervention, CI), and/or over time (Before-After, BA). Studies that did not have a comparator were coded and included in the analysis but noted separately. This was done to include policy studies and others that seldom follow quasi-experimental study design, but whose outcomes are still of importance to this study.

Outcomes Any outcome-related impacts on ecosystems, trade, socio-economic outcomes, governance, management or policy were included, e.g. the effects of MSC certification on health of fish populations as well as on the interactions between stakeholders, such as changes in partnerships or conflict, or changes in consumer awareness of seafood sustainability issues.

Relevant types of study design No study design types were excluded, except syntheses (e.g. systematic reviews, systematic maps, meta-analyses or meta-syntheses). This was done to gain a more comprehensive understanding of the kind of evidence generated about effects of the MSC. Syntheses were excluded, noted separately and used as a source of additional eligible articles. Given that syntheses summarise findings across an overlapping set of articles that may already be included in the map, they are excluded to avoid double-counting.

Language Only articles published in English are included.

We acknowledge that the decision to restrict the survey to texts written in English may introduce a bias by missing relevant articles that have been published in a different language. For example, articles conducted in

developing countries may be under-represented where the official language is not English.

Date The map includes articles from 1997 to January 2019.

Screening process

All articles were uploaded to Colandr.¹ On importing the references to the platform, each title and abstract was screened by 2 coders, and decisions only taken when both agreed on the inclusion/exclusion of articles. When consensus couldn't be reached, a precautionary approach was adopted, and articles were included.

The full-texts of each included article were then sourced, where accessible, and individually uploaded for full-text screening. Full-text screening was performed by four coders, with each article being screened by two coders. If any articles were excluded at this stage, reasons for exclusion were recorded. See Additional file 5.

Study validity assessment

No critical appraisal of study validity was performed beyond coding the study design and data sources.

Data coding and extraction strategy

The extraction sheet (see Additional file 6) was developed with input from the advisory group following testing with coders. The four coders who conducted the screening process also performed meta-data extraction. These coders met with the lead author on a weekly basis to discuss areas of concern. When any pair of coders was unsure of the coding for an article, all four read the article and decided by consensus. Articles that have been authored by coders or systematic reviewers, or other members of their organisations, were coded by other systematic reviewers, eliminating the risk of bias due to potential conflict of interest. All coding was done using Colandr's web platform for data extraction. All coding took place in the period 2 February–15 May 2019.

During meta-data extraction, the coders identified several cases where categorisation could not be determined. The coders discussed each case during group calls. Each issue was discussed, and a solution unanimously agreed. Altogether 15 cases were flagged and were rectified in the following ways: 5 issues regarded lack of clarity in which of the available coding categories should be applied (e.g., what kind of study design the article employed), 10 queries regarded whether an article should be included or

excluded (of these 5 were kept and 5 were excluded). In cases where articles had missing or unclear information, the corresponding author was contacted to obtain it.

Data mapping method

On completion of the coding, all information was exported from Colandr into a csv file. This included all bibliographic information as well as all data coded as part of the meta-data extraction process (such as study design, geographic location, fishery characteristics, etc.).

Content analysis was used to find topic and outcome categories. These were determined through a systematic categorisation based on common themes and patterns [22]. First, each article's abstract was read multiple times to achieve immersion in the subject matter. The first impressions from the initial readings were captured in notes. These were further refined into codes and labels that reflected the key topics and outcomes of the articles. The codes and labels were then sorted into categories that were used to classify and group the articles into meaningful clusters. The topic categories were: economic, social, governance, environment and Voluntary Sustainability Standards (VSS). The latter category refers to articles about the general characteristics of processes and governance structures of the MSC as an example of VSS. Additionally, the articles were sub-categorised according to the scale (i.e., whether it occurred at a global/regional level or was based on a case study) and the perspective of the research (i.e., whether it was based on theory or empirical evidence).

To capture the types of outcomes or effects for which evidence is documented, the outcomes as they had been reported were captured as free-text. For consistency, the outcomes were first categorised using the topic categories (except for VSS, as there were no 'VSS outcomes' found). Sub-categories were subsequently defined using content analysis. Outcomes are any effects noted in the publication because of the intervention (i.e., because of MSC certification or interactions with the MSC program as a whole). These include outcomes such as price premiums in sales of certified products (i.e., where a higher price in certified products is found) or improved status of fish populations (e.g., increased biomass of fish populations targeted by certified fisheries). The outcome categories were: Environmental (ecosystems & habitats, research actions, stock status & fishing pressure), Social (changes in relationships, reputation, governmental support, social capital, accessibility to the programme), Economic (consumer awareness & willingness to pay, market access, price premium), and Governance (management, emergence of other VSS, interactions between MSC and national bodies and resource control). All content analysis was performed by the lead author. For a full list and

¹ Colandr provides a web-based platform to perform systematic maps or reviews and includes the steps required including planning, title and abstract screening, full-text screening and data extraction. It is available at <http://www.colandrapp.com>.

description of the outcome categories and sub-categories, refer to Additional file 7.

Note that one article could have many outcomes, and these could be classified under the same or different topic sub-categories. For example Selden et al. [39] examines the discard rates, bycatch rates, observer coverage and gear impacts of MSC certified and non-certified fisheries in the US. The article describes multiple outcomes, however they were all assigned to the 'ecosystems and habitats' subcategory within the 'environment' category and considered as a single occurrence. Instead, an article like Bellchambers et al. [4] that examines as outcomes price premiums, market access and government support, was coded assigning the outcomes to the 'economic' and 'social' (the latter outcome) categories. As such, the count of number of occurrences of outcome categories and sub-categories is the number of different articles in which this type of outcome is featured, rather than the absolute number of outcomes observed across all article.

On completion of content analysis, data were summarised qualitatively and quantitatively and visualised to identify and interpret patterns. The raw data can be found in Additional file 3.

Knowledge gaps and clusters identification strategy

The total number of articles per category was counted and cross-tabulations of those counts along key variables were used to create structured matrices or bar plots, and to highlight areas with high or low concentrations of articles representing knowledge gaps and clusters. The advisory group met on 20 and 28 May 2019 to discuss and identify topics that lacked evidence and are poorly studied, using the structured matrices as references. The group decided that using the MSC's Theory of Change provided a useful framework to identify clusters and gaps concerning the effects of the MSC program, because, by design, it identifies the expected outcomes and can be used to map out unintended consequences on the different actors and stakeholders involved in or affected by use of the MSC Standards and ecolabel. Knowledge gaps and clusters are described in the results and conclusion.

Results

Overall descriptive statistics

Figure 2 shows the ROSES flow diagram to summarise the systematic process, from searching and screening of articles, to coding [20]. The process began with 771 search results with 298 duplicates. A further 150 were excluded at the title and abstract stage for reasons already mentioned: they were not written in English, or they did not belong to the target population (e.g., focused on sustainability standards in forests), or to the intended intervention (e.g., focused on an alternative seafood

ecolabelling program other than the MSC). Also, articles written by the MSC about the MSC simply for informational purposes (e.g. webpages on 'how to become certified' or 'where to find a supplier') were excluded. This left 323 articles available for full-text screening; 52 of these were irretrievable. The full-texts were irretrievable for the following reasons: books/book chapters or conference proceedings that were unavailable given institutional subscriptions ($n=31$), journal articles unavailable given institutional subscriptions ($n=6$), could not be located ($n=8$) or were no longer archived ($n=7$). For a full list of these, see Additional file 8. While 52 irretrievable texts may seem significant, the majority of these are chapters belonging to the same books, thus the overall number of independent articles is lower. Furthermore, a review of their titles and abstracts suggested that few, if any, were likely to pass the full PICO criteria. As such it is unlikely that the irretrievable texts would have meaningfully changed the evidence base (i.e. included articles) had they been screened.

At full-text screening stage, 206 full-texts were excluded for not meeting the PICO inclusion criteria. A full list of these, with their reasons for exclusion, are in Additional file 5. Full-text screening identified 28 articles that met all the inclusion criteria. A further 37 were also included but noted separately as they studied the impacts of the MSC but lacked comparators and a study design that was considered best practice in detecting or attributing change. Thus, 65 articles were included in the systematic map in an accessible excel table (see Additional file 3 spreadsheets entitled 'Included (with comparators)' and 'Included (without comparators)'). A further 108 articles have been included in this narrative synthesis but noted separately and marked as 'About MSC (excluded)' (see Additional file 3 spreadsheet entitled 'About MSC (excluded)'). As described in Table 1, these focused on the MSC, thus meeting the Population and Intervention inclusion criteria, but did not meet the Outcome criteria, i.e., they did not explicitly study an impact of the MSC, they simply describe the MSC. These were coded to satisfy a secondary aim of this report; to describe and characterise all literature focusing on the MSC. The results of these 'About MSC (excluded)' papers are included in the Results sections under 'Topics' and 'Characterising the MSC literature'. As such, 173 articles were coded and described in the narrative synthesis. 38% of this literature (16% of which uses comparators) can be used to answer the question; 'what do we know about the impacts of the MSC ecolabelling program'. See Table 1 for an overview of the application of inclusion/exclusion criteria and total articles meeting each (Additional file 3 includes a list and meta-data of all the included full-texts and 'About MSC (excluded)' full-texts. Additional file 5 includes all articles

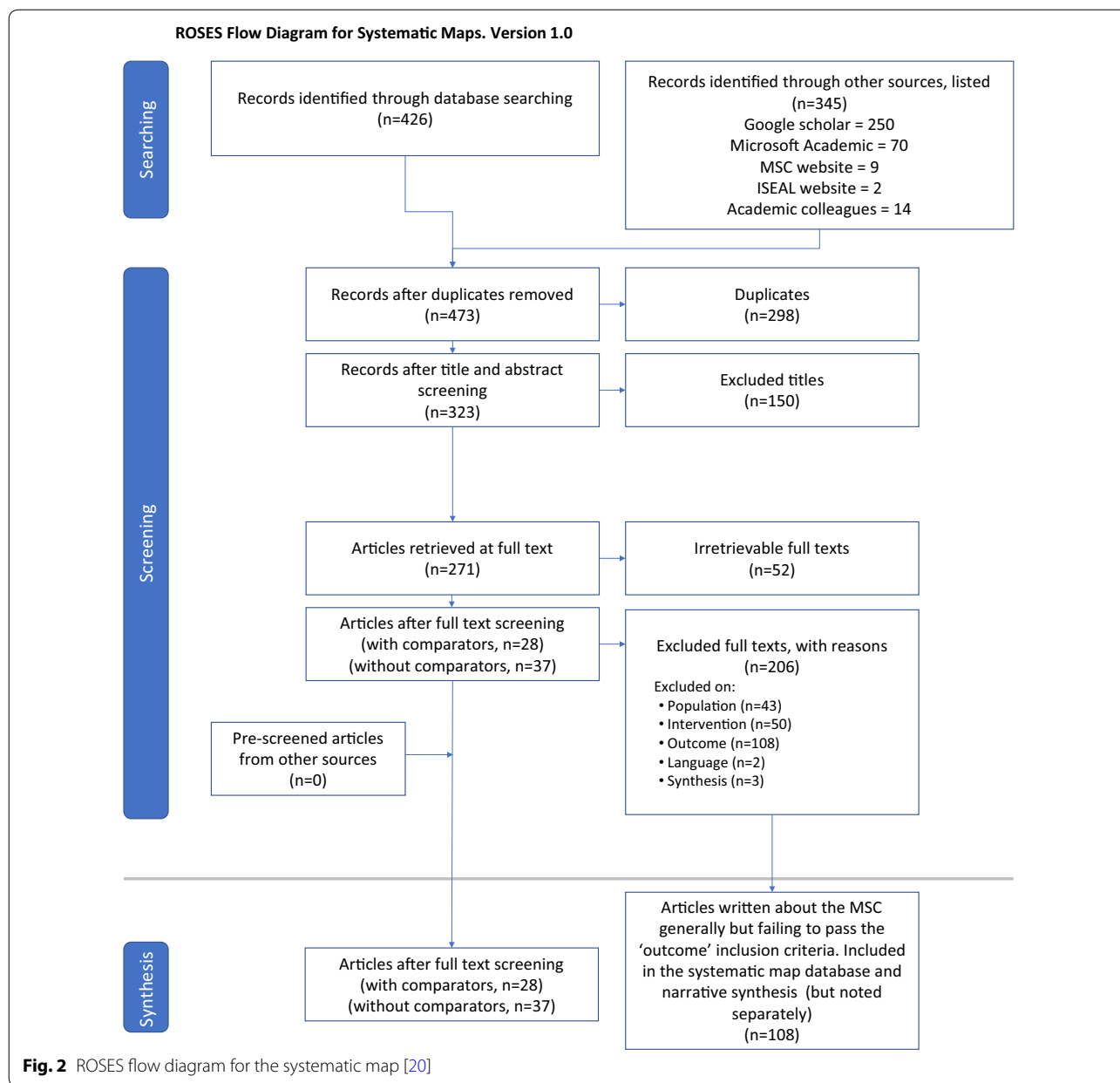


Fig. 2 ROSES flow diagram for the systematic map [20]

that failed to meet the PICO inclusion criteria and were excluded from the narrative synthesis).

Publication year

Figure 3 shows the number of articles published on the MSC per year. For the first 10 years of the program, the median number of articles per annum was 3. In the second decade, this rose to a median of 11 per year. The greatest number of articles published was in 2016 (n=29), in part due to a special issue in *Fisheries Research* on ‘Fisheries certification and ecolabelling: benefits, challenges and solutions.’

Literature type

The articles coded (n=173) are of the following literature types: journal articles (n=119), grey literature (n=21), commentary (e.g. letters to the editor) (n=9), conference proceedings (n=9), dissertations (n=9) and books/book chapters (n=6).

Study design and data collection methods

As stated, 65 articles are included, however, only 28 used comparators. The study designs of those with comparators were Before–After (BA) (n=8), Control-Intervention (CI) (n=15) and Before–After-Control-Intervention (BACI) (n=5). The remainder of the studies used the

Table 1 Overview of application of inclusion/exclusion criteria

	Effect of the MSC (included)		About MSC (excluded)	Excluded
Population	Yes	Yes	Yes	No
Intervention	Yes	Yes	Yes	No
Comparator	Yes	No ^a	No	No
Outcome	Yes— Effect of MSC	Yes— Effect of MSC	No—Description of MSC (no effect explicitly studied) ^b	No
Total number	28	37	108	206

^a Included and coded but noted separately, as per the protocol, for not having a Comparator

^b Excluded, as per the protocol, for not meeting Outcome and Comparator criteria, but coded and discussed in narrative synthesis for meeting Population and Intervention criteria to satisfy a secondary aim of the report

following study designs; descriptive case study (n=14), narrative analysis (n=12), model (n=5), theoretical analysis (n=2), quantitative review (n=2), statistical analysis (n=1) and value chain analysis (n=1).

Table 2 shows number of documents within each study design by data source. Note that an article could have more than one data source.

Topic

We divided the systematic map results across 4 broad topic categories: environmental, social, economic and governance (see Additional file 7). The categories were non-exclusive. For the included studies (n=65), economics was the most studied topic (39%, with comparators n=20, without comparators n=14). Governance

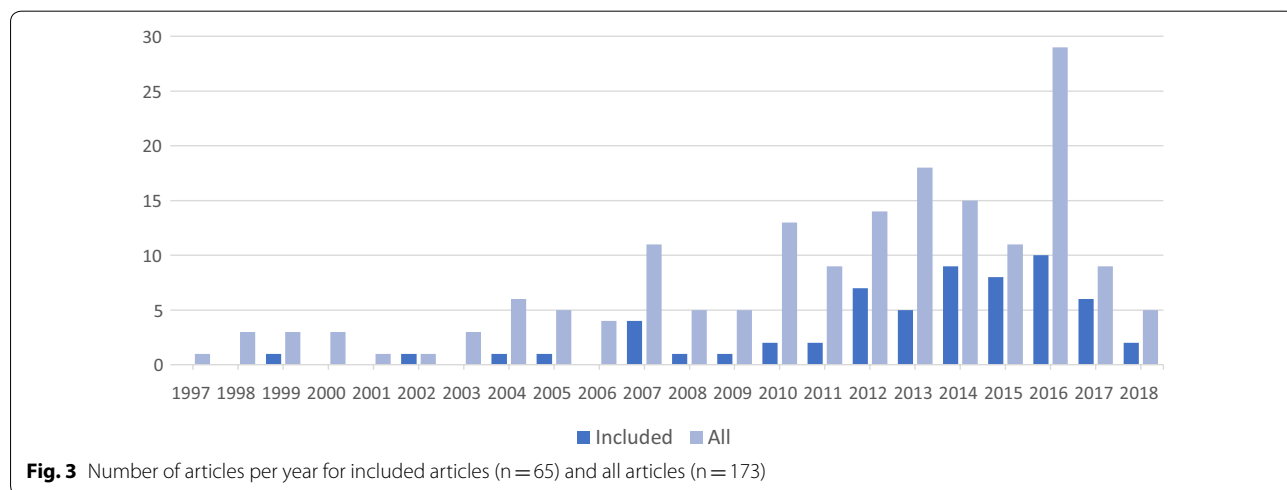


Fig. 3 Number of articles per year for included articles (n=65) and all articles (n=173)

Table 2 Number of included articles by study design and data source

Study design	Total	Data source			
		Governmental/organisational data	Secondary sources	Interviews/surveys	Direct observation
BA	8	8	3	0	0
BACI	5	5	1	0	0
CI	15	5	4	6	4
Descriptive case study	14	9	10	7	2
Model	5	3	1	0	2
Descriptive analysis	12	4	10	6	1
Statistical analysis	1	1	0	0	0
Theoretical analysis	2	0	2	2	1
Value chain analysis	1	0	1	1	1

Note that one article may use multiple datasources

and environmental effects were the focus in 30% (with comparators $n=7$, without comparators $n=19$) and 24% (with comparators $n=13$, without comparators $n=8$) of the occurrences, respectively. The social category occurred in only 7% (with comparators $n=0$, without comparators $n=6$) of articles.

An examination of topic categories across the 108 articles marked as 'About MSC (excluded)' (i.e., those that describe the MSC but do not explicitly analyse its effects) showed a slightly different spread. This 'excluded' literature includes the 'Voluntary Sustainability Standard (VSS)' category. This category captures articles that study MSC's program structure and functioning: its emergence, processes, potential for impact and comparisons with other VSS. 45% ($n=57$) of 'excluded' literature was categorised as VSS, 30% ($n=38$) as governance, 10% ($n=14$) as economic, 8% ($n=10$) as environmental and 6% ($n=8$) as social.

Each publication was further classified as theoretical (based upon hypotheticals or thought experiments and/or utilising conceptual frameworks) or empirical (based upon evidence and observation) and as regional or global in focus, and whether it was a case study (see Additional file 7). Figure 4 shows structured matrices of these categories' combinations for included studies ($n=65$) and 'excluded' studies ($n=108$) (top and bottom plots, respectively). For included studies, empirical economic case studies were the most common and empirical environmental studies at a regional/global scale were the second most common. For 'excluded' articles, empirical regional/global studies on the MSC as a VSS were a significant focus as well as theoretical studies focusing on the governance topic.

This array of included articles shows knowledge clusters around economic and environmental impacts with knowledge gaps relating to the governance and social related outcomes of the program. The low numbers of articles addressing social and governance topics may, in part, be explained by a lack of research interest or by the difficulty in conducting quasi-experimental studies. For instance, information on certain social and governance effects may be less straightforward than collecting the retail price of eco-labelled cod fillets or accessing global stock assessment data. In addition, establishing causality by identifying appropriate counterfactuals (i.e., what the impacts would have been in the absence of certification) and taking account of relevant co-variables may be challenging [42]. Matching a 'certified' or 'intervention' group with a 'control' is non-trivial in marine systems, although not impossible as demonstrated by Birkenbach et al. [5] and Gill et al. [15]. Furthermore, to compensate for uncertainties, high sample sizes are required creating logistical and financial barriers [42]. The fact that an

additional 19 articles on governance and 6 articles on social impacts were found when allowing for articles that do not explicitly use comparators, suggests that barriers related to data and study design may partly explain this research gap. However, another contributing factor may be the disciplines surrounding these fields of research which tend to focus on qualitative case studies. As such the discipline specific study methods may not lend themselves to quasi-experimental study designs [37].

Methodological challenges in acquiring the evidence base are also present in other topic categories. For environmental studies, the complexity and dynamics of marine systems makes finding counterfactuals and adequately considering covariates difficult. "Fisheries and the marine populations they target shift on seasonal or even daily basis, are subject to external drivers (e.g. migration patterns, climatological processes), and have leaky boundaries (i.e. changes made by one fishery can affect other fisheries that operate in the same area, making changes difficult to attribute or detect)" [25]. Furthermore, there are marked differences amongst fisheries, so that matching 'control' and 'intervention' groups is difficult when one needs to account for species, gear, management systems, ecosystems etc. Thus, it is not surprising that few articles on the MSC use counterfactuals.

The excluded literature (i.e., articles about the MSC program but not necessarily investigating its impacts) provides a useful indicator of research interests. Excluded literature ($n=108$) focuses on governance topics 30% of the time and social topics 6%. As such, there is relatively greater research interest in governance topics than what seen in the literature documenting MSC impacts, but a similar gap is found in the social category. While this may partly be due to the lack of social requirements in MSC's Fishery Standard, other than governance-related aspects present in Principle 3 (such as stakeholder participation in decision-making), it suggests the lack of research focus isn't explained just by practical limitations such as lack of data.

For the governance topic, however, there appears to be a high degree of research interest, especially from a theoretical perspective. This is because social scientists can use the MSC as a conveniently well-documented natural experiment in how private-public governance systems function. Social science scholars consider the MSC, together with the Forestry Stewardship Council, as one of the most advanced examples of VSS, given their long history and the attention to standard-setting best practice, such as stakeholder involvement, transparency, and science-based processes [3, 19]. These articles focus on the emergence and evolution of VSS (e.g., their "institutionalization"), and use the MSC to better understand wider questions around legitimacy and accountability



Fig. 4 Structured matrices showing the number of included (top) and excluded (bottom) articles focusing on each topic category, by geographic scale (global or case study) and study perspective (empirical or theoretical). The darker the colour the greater the number of articles in that cross tabulation of topic category and study scale/study perspective

Table 3 Percentage of included impact articles focusing on each topic and outcome, showing separately those with and without comparators

Topic category	Outcome category	% of total with comparators	% of total without comparators	% of total included articles
Environmental	Stock status and fishing pressure	20	4	10
	Ecosystems and habitats	20	9	13
	Research actions	18	4	9
Social	Reputation	0	3	2
	Social capital	0	9	5
	Government support	0	5	3
	Changes in relationships	0	6	4
	Accessibility	0	6	4
Economic	Price premium	14	8	10
	Market access	0	14	8
	Willingness to pay and consumer awareness	10	6	8
	Other	4	3	4
Governance	Management	14	6	8
	Emergence of other VSS	0	5	3
	Interactions between MSC and supra/national bodies	0	8	5
	Resource control	0	6	4

Total number of outcome type occurrences for included articles with comparators (n = 50), total number of outcome type occurrences for included articles without comparators (n = 80) and total number of outcome type occurrences for included articles with and without comparators (n = 130)

of non-state organizations [7, 17–19]. Furthermore, the MSC provides researchers with an interesting case to study contemporary political processes, such as information-based/informational governance applied to the marine environment [38, 43].

Outcomes

The outcome categories and sub-categories describe the effects of the MSC programme as reported in the article (without any reference to whether the effect was positive or negative). We recorded the number of articles that featured each outcome type.

For included articles with comparators (n = 28), a total of 50 outcome types was recorded, for included articles without comparators (n = 37), a total of 80 outcomes types was recorded. Table 3 shows that for articles with comparators (n = 28), the most commonly studied effects were environmental; stock status and fishing pressure (20% of recorded outcome types, n = 10), ecosystems and habitats (20% of recorded outcome types, n = 10) and research actions (18% of recorded outcome types, n = 9). Economic effects were also a focus with price premium (14% of recorded outcome types, n = 7) and willingness to pay and consumer awareness (10% of recorded outcome types, n = 5) reported. Governance was studied with regards to changes in fisheries management (14%, n = 7). No articles with comparators reported any social effects.

Including the articles that studied the impacts of the MSC but did not use comparators (n = 37), increases the variety of effects reported. While the social category was still underrepresented, there were reports of MSC affecting reputation (3%), social capital (9%), government support (5%), changes in stakeholder relationships (6%) and accessibility (6%). Within the governance category, how MSC affects interactions between the organisation and other national or supranational bodies (8%), resource control (6%) and the emergence of other VSS (5%) were also reported.

Figure 5 is a tree-map indicating the proportion of times each outcome category is described in the included articles (n = 65). Environmental outcomes were the most frequently reported, with the greatest foci being the impacts of fishing on ecosystems, habitats and stock status. Economic outcomes were also well-represented, particularly price premiums and market access. Outcomes under social and governance categories were less common foci of these articles.

This array of outcomes shows knowledge clusters around certain types of economic and environmental impacts and gaps pertaining to other types of economic and environmental outcomes as well as governance and social impacts.

The literature about economic effects of the MSC focuses on the retail side (i.e., price premiums and market access), but seldom engages with changes in the

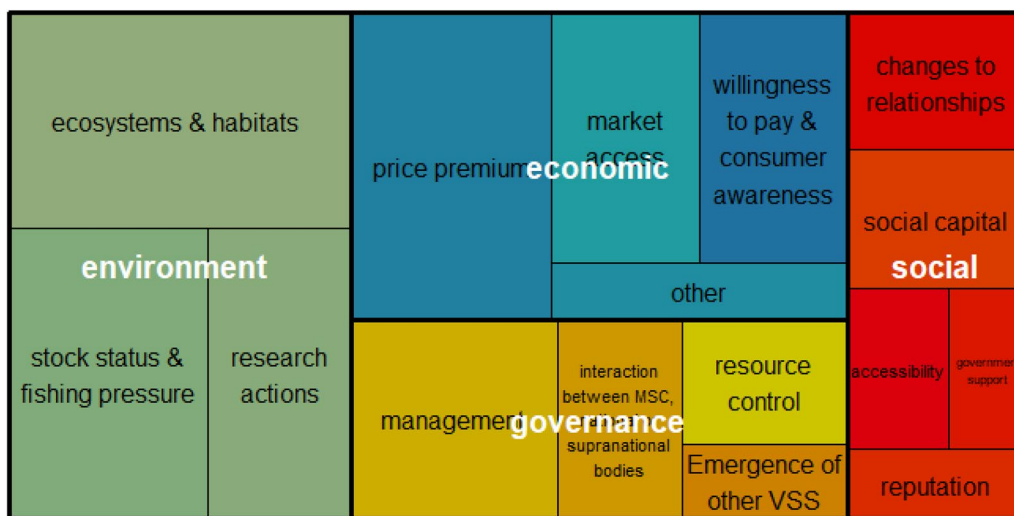


Fig. 5 Tree map diagram of topics across the included articles (n = 65)

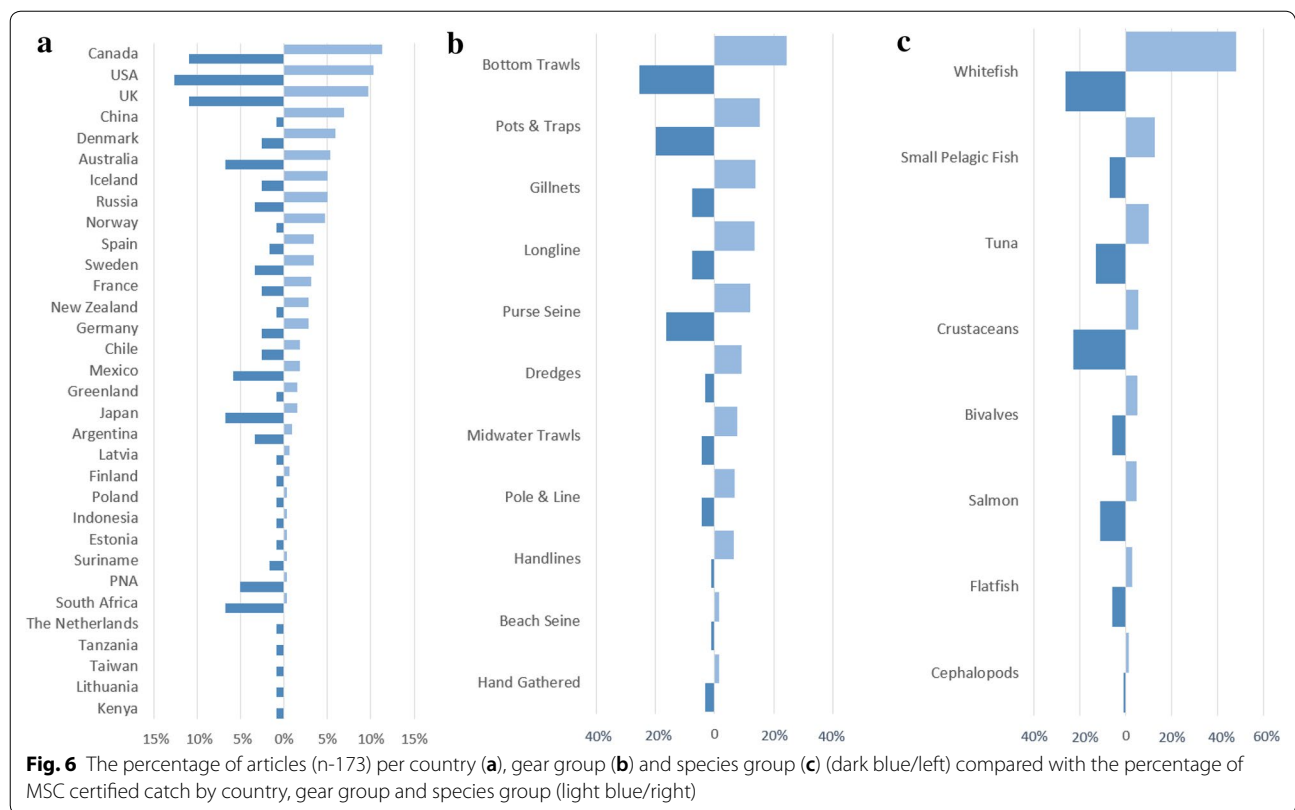
intermediate stages of the supply chain before it reaches consumers. For example, there is no literature that seeks to understand whether the supply chain itself is altered by certification (e.g., does certification change who producers sell to or buyers source from?). The Chain of Custody Standard and certification is conspicuous by its near-absence, being analysed in only one publication [27]. This occurs despite it being a key mechanism to the MSC’s Theory of Change, even in its simplest representations (i.e., the MSC mission statement, and simplified diagram on the MSC website, Fig. 1). Without Chain of Custody certification, seafood products cannot display the ecolabel and thus enjoy associated price premiums or increases in demand. Chain of Custody certification might also help to improve processor efficiency and improve traceability by creating an incentive for product documentation and tracking systems [31]. These are important effects that could help us better understand how the market-mechanism of ecolabels work and consider some of the emerging effects of the ecolabelling scheme that are not captured in Fig. 1.

On the producer side, the MSC Theory of Change posits that fisheries, will improve their practice to align with the Fisheries Standard requirements. The two environmental outcomes most commonly observed, changes in stock health and ecosystem impacts, mirror the requirements of Principle 1 and 2 of the Fishery Standard. The most reported outcome in the governance category is changes in management which corresponds with the Standard’s third principle. Thus, the literature typically focusses on the initial producer and the final consumer levels but says very little about what happens in between.

Knowledge gaps also include emerging effects, defined as the results of complex interactions between the MSC and other agents within the socio-ecological system in which it operates that may be a by-product of the Theory of Change in action. These fall broadly into the governance or social categories that are not generally represented in the diagrams of MSC’s Theory of Change (see Fig. 1 and Additional file 1). These may include aspects such as relationship changes (between government officials, fishers, industry and scientists), environmental awareness, reputation or impacts on fishing communities and livelihoods, to name a few, or indirect effects caused by difficulties in accessing the program for particular fishery types, i.e., small-scale and lower income country fisheries, such as market exclusion. The gap as it relates to accessibility is pronounced with only 4 relevant articles. However, some aspects of MSC and accessibility (e.g., a description of barriers to entry in the program) are described in excluded articles in the VSS category, although the direct impacts, e.g., on developing world or small-scale fisheries themselves, are not studied. Kreis et al. [26] discuss how different representations of results chains (i.e. theory of change diagrams) can mask potential areas worth monitoring. Thus, representing the MSC’s Theory of Change in different ways could help highlight areas worth studying to researchers interested in better understanding interventions and their impacts.

Characterising the MSC literature

In order to satisfy the secondary aims of the report, country of origin, economic development and fishery characteristics of all the captured literature on the MSC (i.e., included and excluded articles) were documented



(n = 173). Country of origin, region, economic development and fishery characteristics were only captured if a particular fishery or group of fisheries were the focus of a publication (i.e. case study), they were not reported if a fishery was briefly cited as a single example in an article with a broader focus.

Country of origin, region and economic development

Published case studies were found for fisheries in 33 countries. The most commonly studied were: the USA (n = 15), Canada (n = 13) and the UK (n = 13). Just under a third focused on Europe (28%, n = 27), 24% on North America (n = 23), 15% on Oceania (n = 14), 14% on Asia (n = 13), 9% on South America (n = 9) and 9% on Africa (n = 9) (see Fig. 6a).

Countries were further categorised according to four income groups (low, lower-middle, upper-middle and high) according to the World Bank List of Economies [45]. Most articles (63%, n = 74) analysed impacts in high income countries. Upper middle and lower middle-income countries were the focus of respectively 21% and 11% of articles, and only one publication referred to a low-income country (Tanzania).

It is important to note that 7 of the included case studies focused on non-certified fisheries, exploring their

suitability and potential for certification (including Tanzania).

The tendency for articles to focus on the MSC in the high-income countries of Europe, North America and the Antipodes reflects the global distribution of certified fisheries in the program. However, the proportion of articles on low-income countries is less than the 12.5% of fisheries in the program that are certified from lower income countries. On the other hand, some countries have received a greater focus despite their limited representation in the MSC. These countries include (in no particular order) South Africa, the eight member countries of the Parties to the Nauru Agreement (PNA), Mexico and Japan. The disproportionate focus on these countries, compared to the proportion of certified fisheries in the program, is likely due to the specific interest in a small number of certified fisheries. For example, South Africa has only one certified fishery but had 8 articles. This may be because it was one of the first developing world fisheries to become certified, it is the only certified fishery in Africa and has experienced significant fisheries management improvements that can be seen as a “success story”, including a 90% reduction in seabird bycatch and changes in fisheries management to better incorporate science [9]. The PNA includes 8 small island developing states (Federated States of Micronesia, Kiribati, the

Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu) that have signed a joint fishery management arrangement. The PNA might have drawn researchers' attention due to the fact that tuna are high value, highly traded species, with complex management due to large scale migration, and fishing grounds crossing international management boundaries. In addition, the PNA free-school skipjack purse-seine fishery drew attention for fast-tracking an agreement on the skipjack Precautionary Reference Points and Harvest Control Rules, as a means of maintaining MSC Certification [1].

While lower income countries are still the minority of MSC certified fisheries, their involvement is growing with the number of lower income fisheries engaged in the programme having more than doubled between 2017 and 2019, thus the low representation of these geographies is a gap in the literature.

Fishery characteristics

In the MSC programme, a 'fishery' is defined as a group of vessels, targeting particular fish stock/s, with particular gear/s in a particular geographic area. The species groups and gear types used [11] where fishing activity occurs were coded. Not all articles focused on a particular fishery or group of fisheries, and of those that did, not all articles provided details on the fisheries' characteristics.

Figure 6b illustrates the most common species groups noted: whitefish (n=32), crustaceans (n=30), tuna (n=15), salmon (n=13) and small pelagic fish (n=8). Whitefish includes species mostly of the Gadiform family such as cod, haddock, hoki, hake and pollock. The most common gears reported were: bottom trawls (n=25), pots and traps (n=21) and purse seine (n=15), see Fig. 6c. Gear groups were classified according to the descriptions and names provided by the FAO [12].

As expected, the most commonly occurring species and gear groups generally mirrored the fisheries most commonly occurring in the program (i.e., whitefish and bottom trawl fisheries) and most widely traded (i.e., tuna and salmon). An exception were crustaceans, the second most reported species (26%, n=30) despite only representing 15% of certified fisheries in the program, accounting for 5% of certified catch. Two fisheries in particular, the Western Australian Rock Lobster and Mexican Baja California Red Rock Lobster, were the focus of several articles. The Australian lobster fishery was the first certified by the MSC in 2000 and the Mexican fishery was one of the first developing-world fisheries in the program, which may explain why these fisheries are commonly reported case studies.

A reported critique of the MSC programme is that it is not accessible to small-scale fisheries [33, 34]. 12 articles (7%, included literature n=6, excluded literature n=8)

focused explicitly on small-scale fisheries, which is lower than the proportion of MSC certified small-scale fisheries (17%). There is currently no official definition of a small-scale fishery, hence, if an article identified a fishery as 'small-scale' it was coded as such. We endeavoured to quantify the scale of the small-scale fisheries mentioned in articles by size and value. Only 6 gave any indication of scale and none provided an explanation of how 'small-scale fishery' was defined. Of the small-scale fisheries that did provide details, number of vessels (ranging from 2 to 400), size of vessels (2–7 m), tonnage (ranging from 83 to 280 t/year) and number of crewmen on each vessel (12) were described.

Limitations of the map

Limitations of searching

Firstly, while the search strategy was considered comprehensive (especially given the broad search-string), finite time and resources meant that additional sources could not be searched. This is a potentially problematic for grey literature that may have been found on other organisations' websites (e.g. BirdLife International).

Second, only English language literature was searched which can create a potential bias. While the online databases would have presented relevant non-English literature where it existed, the grey-literature may have been influenced by language limitations. This may also introduce the 'Tower of Babel' bias wherein authors generally choose to publish significant results in English [16]. Thus, more work to include other languages and consolidate grey literature could be done in future syntheses.

Thirdly, articles were primarily limited to articles that are available electronically or online and, for independent evaluations not published in peer-reviewed literature, made accessible by the commissioning organisations. Access to articles was also limited by the library collections to which the research team subscribed (which largely accounts for the number of irretrievable articles). It is acknowledged that there exists a wealth of literature commissioned or developed by governments or associations regarding the MSC (e.g., Australian Government funded Fisheries Research and Development Corporation (FRDC) or the South African Deep-Sea Trawling Association reports). However, these articles are not usually available through commonly accessed online databases or found via search engines. As such, it is likely that there are reports that may not have been found during the search process, representing a potential gap in our search process.

Limitations in coding and synthesis

Caveats regarding how data have been synthesised and presented should be considered which may limit the

interpretation of results. Data extraction strove to only capture general characteristics of articles. The need to categorise publication by topic and outcome means that important nuances have been lost and some degree of subjectivity in assigning articles to topic categories or sub-categories is inevitable. Furthermore, no critical appraisal of directionality, effect size, or quality of information was conducted, contrary to what is done with systematic reviews that tend to be more detailed. Only study design and data sources were captured, allowing a review of methods and giving some indirect indication of data availability, but not the assessment of susceptibility to biases or commentary as to whether the impact described actually occurred.

Limitations of the evidence base

With regards to the articles ultimately included in the map, there are shortcomings in the evidence base or potential biases in the pool of articles found.

Few articles described the spatial scale of the fisheries in extensive detail. It is for this reason that coordinates and FAO fishing areas were not coded (as described in 'deviations from protocol'), however country and regional data were still captured. While this is generally believed to be accurate, it is known that fishing activities may cover various countries' Exclusive Economic Zones (EEZ) or a fishery may be composed of vessels registered to one country flag with the fishing activity occurring in another country. If this was the case, reports may not have described these intricacies, potentially biasing the geographic data. Additionally, the map shows a geographical bias towards developed countries. While this generally reflects the spread of certified fisheries in the programme, some countries that have a number of certified fisheries have a minor contribution to the evidence base (e.g. China, and South American countries). Searching for and including literature in other languages (e.g. Spanish, Portuguese, Russian and Mandarin) may have identified more evidence from relevant geographical regions.

Conclusion

This systematic map has provided a first comprehensive synthesis of evidence available on the impacts of the MSC program, framed within a wider overview of all the topics of interest to researchers related to this certification and ecolabelling scheme. The map shows a growing interest in the MSC with 173 published articles found. These articles encompassed a diversity of topics and study designs, reflecting the complex nature of the program that is at the interface between private voluntary commitments

and public governance, civil society and commercial actors and the human and natural worlds.

The systematic map illuminates some general patterns in available evidence, capturing the impacts of the program from environmental, social, economic and governance perspectives. Of all articles ($n=173$), 38% ($n=65$) focused on impacts of the MSC program, and of these less than half ($n=28$) passed the map's study design inclusion criteria (16% of total). This points to an issue in the quality of evidence. This is partly explained by the methodological and resource challenges associated with obtaining counterfactuals in marine socio-ecological systems, but may also be the result of discipline-specific study methods (e.g., nuanced descriptions of social processes) do not always lend themselves to quasi-experimental study designs [37].

For those that did pass all the inclusion criteria (and therefore can detect or attribute an impact or change to the MSC programme), 50% were about economic effects (6 BA, 11 CI and 1 BACI study designs), 32.5% about environmental effects (6 BA, 2 CI and 4 BACI study designs), 17.5% (7 BA, 0 CI and 0 BACI study designs) about governance and 0% on social effects (i.e., social effects not already captured under the governance or economic categories, such as empowerment of a fisher community). These articles documented a variety of outcomes of MSC interventions with the most common including price premiums, market access, changes in stock health, ecosystem impacts and fisheries management changes.

The general literature ($n=108$) differs from the literature on impacts ($n=65$) in that there is a cluster around studying the governance of the MSC itself as Voluntary Sustainability Standard, often seen as a model for voluntary, information-based governance processes that is easier to study due to access to documentation on decision-making and consultation processes.

The most reported outcomes (i.e. knowledge clusters) generally align with the 3 principles of the MSC's Fishery Standard (sustainable fish stocks, minimising environmental impact and effective fisheries management) and some of the associated market benefits of certification (price premiums and market access). Thus, the literature typically covers impacts surrounding the initial producer and consumer level interactions with programme. However, gaps emerge in the areas in between. Little to no focus seems to be placed on the effect of Chain of Custody (CoC) certification or how the programme effects supply chains. This gap is also present in the general literature on the MSC, suggesting that it is not simply due to lack of data but rather it is an overlooked topic of

investigation. The CoC certification is a key mechanism that allows for the use of the eco-label and potential associated benefits. Research of these impacts could improve our understanding of the market-mechanisms at play and help us consider emerging effects of the programme. Other emerging impacts that are not covered in the literature include governance and societal effects (e.g., impacts on fishing community well-being, livelihoods, changes in relationships etc.). Other gaps pertain to geographical representation. Relatively little representation of developing world fisheries might reflect their representation within the program, as might be confirmed by a few fisheries receiving the attention of several articles.

It is important that the identified knowledge gaps are filled as the human dimension of standard-setting and specifically the social and economic dynamics that link the supply chain actors are the key mechanisms through which the public can influence sustainability, through which market inclusion or exclusion operates, and inequality can be generated. Furthermore, building an understanding of these type of effects can be instrumental to improving the MSC program by identifying mechanisms and processes that are within the organization's sphere of influence. As such, filling these knowledge gaps denotes an important area for future research.

Implications for management and policy

Two of the key knowledge gaps revealed in this map concern the effects of the MSC in the intermediate stages of the supply chain before seafood reaches consumers as well as the effects of certification on harvester communities (i.e. impacts on livelihoods, social capital, etc.). As ecolabelling represents a natural experiment in incentivising behaviour change through a multi-stakeholder process, filling this knowledge gap will not only help to understand the underlying processes of MSC certification, but more widely the implications and mechanisms involved in marine sustainability interventions which may help to inform policy and management.

Furthermore, in an increasingly globalised world, where more than two thirds of trade occurs through global value chains, it is important to understand the effects of trade and supply chain changes on producer communities, such as distributional effects whereby benefits are not accrued to all [46]. Understanding the processes leading to these dynamics is important, not only for the MSC and other standard-setting organisations but more generally so as to account for them in policy and management.

Implications for future research

The MSC program has been growing at a steady rate over the last two decades and is likely to continue growth with more fisheries joining the program as the organisation strives to overcome barriers to entry and help more fisheries on their pathway to sustainability. As such it is imperative that the impacts of the program are monitored and evaluated to determine whether the organisation's Theory of Change is working as intended.

Often, systematic maps are utilised when the scope of a topic is likely to be supported "by an extensive evidence base that would benefit from initial characterisation which may then identify sub-topics for further systematic reviews and/or meta-analyses" [24]. In the case of this report, we have collated a heterogeneous set of articles (from topic and study design perspectives) that do not easily lend themselves to systematic review. This is especially the case given that few articles had comparators and study designs that would allow for inclusion in a systematic review and/or meta-analysis. Literature reviews of the environmental impacts of MSC certification [25] and the effectiveness of MSC (and other VSS) in driving adoption of sustainability practices [36] have already been undertaken. One of the only other sub-groups of articles that could potentially be synthesised in this way are economic articles that calculate the price premium that are (or are not) received by MSC certified seafood in different retail markets. However, this is not considered a priority as other articles (although not having conducted a formal meta-analysis) have summarised these findings (e.g. [6, 8, 40]). As such, future research would benefit from filling the identified knowledge gaps as opposed to further synthesising knowledge clusters. This map has shown that while there is a growing body of evidence there are still important gaps relating to study design, geographical focus and topics that require filling.

Few articles utilise study designs and an evidence base that can robustly detect or attribute change to the MSC. Whilst acknowledging the logistical and methodological difficulties, greater focus on conducting robust quasi-experimental designs would help to better understand the effects of the program. The geographical focus of fishery case studies has largely been in Western Europe, North America and the Antipodes. A greater focus on certified fisheries in lower income countries would be welcomed.

Future research should investigate the social and economic dynamics that link harvesters and supply chain actors and their impact. For example, how does MSC certification effect the composition of supply chains (e.g.

exclusion of non-certified middlemen), whether the MSC impacts the livelihoods of coastal communities or if the MSC certification process encourages greater collaboration between stakeholders or increases conflict between groups.

Supplementary information

Supplementary information accompanies this paper at <https://doi.org/10.1186/s13750-020-0188-9>.

- Additional file 1.** Theory of Change graphic.
- Additional file 2.** ROSES form.
- Additional file 3.** Meta-data.
- Additional file 4.** Additional results.
- Additional file 5.** Excluded fulltexts with reasons.
- Additional file 6.** Data extraction sheet.
- Additional file 7.** Description of topic and outcome categories.
- Additional file 8.** Irretrievable fulltexts.

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Authors' contributions

All the authors contributed to the formulation of the research questions and methodology. CSL and AA conceived of the study, participating in its design and coordination. AA was a major contributor to the writing of the manuscript. CSL, AL, GP and HT helped in the drafting of and review of the report. All authors read and approved the final manuscript.

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AA and CL are employees of the MSC and as such receive salaries from the organisation that is the focus of this systematic map protocol. In this way the MSC has contributed to the financing of this manuscript. However, the MSC is a registered non-profit organisation and charity.

Availability of data and materials

The datasets generated and analysed during this study are included in this published article and its additional information files. Additional data (e.g. on number of certified fisheries or percentage of certified catch) are available from the corresponding author on request.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

AA and CL are employees of the MSC. To avoid this being a potential conflict of interest, the following precautions were taken: non-MSC authors were involved in the development of the manuscript and checked for the risk of selective or biased questions, methodology and analysis. The non-MSC authors have different backgrounds and expertise to ensure a diversity of stakeholder perspectives. The formulation of all questions, methods and analysis was done with the input of all authors. The CEE guidelines and ROSES form were closely followed to ensure an objective approach was adhered to. Furthermore, all screening (at title, abstract and full-text level) was performed by non-MSC staff. Meta-data extraction was performed by 2 non-MSC staff and 2 MSC staff. The majority (up to 75%) of meta-data extraction was performed by non-MSC staff to further reduce the risk of potential impartiality.

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